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ORGANIZATIONAL ALTERNATIVES FOR THE PLANS AND WORKLOAD BRANCH, --ETC(U)

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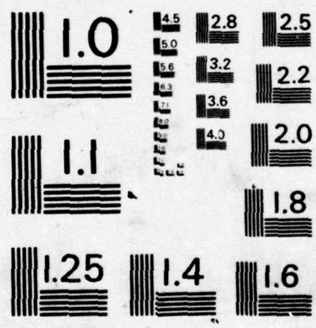

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THESIS

ORGANIZATIONAL ALTERNATIVES
FOR THE PLANS AND WORKLOAD BRANCH,
DESIGN AND FABRICATION DEPARTMENT,
PACIFIC MISSILE TEST CENTER

by

William Harold Winner

September 1976

Thesis Advisor: J. W. Creighton

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This study presents alternatives for optimizing the output of projects and tasks in the Navy's in-house facility for engineering design, manufacturing, maintenance, and repair at the Pacific Missile Test Center, Point Mugu, California. Key departments are analyzed. Alternatives for management consideration are presented. Rationale for various alternatives is reported on. Finally, recommendations for action are made.

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Organizational Alternatives for the
Plans and Workload Branch, Design and
Fabrication Department,
Pacific Missile Test Center

by

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ABSTRACT

This study presents alternatives for optimizing the output of projects and tasks in the Navy's in-house facility for engineering design, manufacturing, maintenance, and repair at the Pacific Missile Test Center, Point Mugu, California. Key departments are analyzed. Alternatives for management consideration are presented. Rationale for various alternatives is reported on. Finally, recommendations for action are made.

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I. INTRODUCTION

Economy in Government has been a driving force behind numerous studies in various agencies, especially in the Defense Department. Since the cessation of hostilities in Southeast Asia, pressure has increased, not only for more non-military services from the Government, but also for a lowering of emphasis on arms and defense. Congress has responded by severely limiting Defense Department budgets and imposing restrictions on how the funds are to be used. As a result, the Services have found it necessary to conduct serious functional and cost analysis reviews of their operations, paring some activities, consolidating others, all for the purpose of obtaining increased efficiency and maintaining effectiveness from limited resources.

Policy guidance on cost effectiveness has carried down through the Department of the Navy to the Naval Air Systems Command field activity at Point Mugu, California, the Pacific Missile Test Center (PMTC). Within the PMTC Command, the Design and Fabrication Department, a service organization of about 400 civilian personnel, has undertaken action towards becoming more cost effective. The Department Head has initiated several studies analyzing function, methods, cost, performance, etc., which, together with guidelines issued from the Command, will be the basis for reshaping the Department along lines of an updated enlightened management team. The

result is expected to be a trim organization operating with increased efficiency, sustaining effectiveness, and giving customers (and the taxpayers) more output for their money.

The purpose of this study is to analyze that segment of the Design and Fabrication Department's Resources Office commonly referred to as "Planning," make recommendations regarding more effective methods of accomplishing its function, and submit a report to the head of the Resources Office and his superior, the Department Head, giving several action alternatives for management consideration.

Some of the benefits expected to be gained are the following:

1. A single method of selecting task executives.

2. A higher level of direct control by supervisors.

3. Increased responsiveness from subordinates resulting from a new-found feeling of being part of the organization.

4. More flexibility in utilization of personnel by first-line supervisors.

5. More commitment on the part of the first-line supervisors to development of employees.

6. Quicker feedback of task status to task executives.

7. Performance evaluations from the supervisors to whom the employee's work is most visible.

8. Closer control on overhead charges.

9. Reduction in staff functions, allowing an increase of available direct labor.

10. Greater awareness on the part of the engineering supervisor of the production controller's function and workload.

11. Greater awareness on the part of the first-line supervisor of the quantity and scope of estimates made by the production controller for outside requests.

12. Improved accuracy of job estimates and status reports leaving the Department.

The following chapter presents a description of the test center, a brief history, and an evaluation of the needs required of it by the Navy. Next, is an analysis of the organization that has evolved. That is followed by alternatives for organization structure to accommodate the test center in its Navy mission with specific recommendations.

II. BACKGROUND

A. HISTORY OF PACIFIC MISSILE TEST CENTER

The Pacific Missile Test Center had its beginning in 1946 [Ref. 1, p. iv-vi] when the Naval Air Missile Test Center (NAMTC) was commissioned at Point Mugu. Prodded by the effective use of pulse-jet and rocket powered missiles developed by the Germans during World War II, the U. S. Navy had consolidated its scattered missile research groups and formed the Pilot-less Aircraft Unit at a desert air station near Mojave, California. The unit was moved to Point Mugu because of significant operating advantages. The more important were the large open-sea test area, the potential instrumentation sites on the off-shore islands and on the mainland atop the 1100-foot Laguna Peak, the mild weather, and the proximity to the industrial complex of the Los Angeles area.

A ten year growth program began in 1948 with a 30 million dollar appropriation from congress for initial construction of headquarters buildings, missile project buildings, and sophisticated laboratory test facilities. Matching the Center's continuing growth was the development of the Navy missile inventory, with such historical names as Lark, Loon (American version of the German V-1 buzz bomb), Gargoyle, Rigel, Sparrow I and II, and Regulur I and II. Missiles were launched seaward from ground-based launchers and then tracked,

at first simply by observers, later with instrumented cameras, and finally with extremely accurate radar. Later on, air-launched missiles were mated to aircraft and fired over the sea test range. Helping with the entire operation were some of the very same German scientists who had developed the V-1 and V-2 missiles, and were brought to this country under "Operation Paperclip."

In 1958, the Pacific Missile Range (PMR) was established from the nucleus of NAMTC. Designated a national missile range, its mission was to provide operating and test range support for the Department of Defense and other Government agencies for launching, tracking, and collecting data for guided missiles, satellites, and space vehicles, underscoring the nation's emerging space program. Geographically, the range extended from launch facilities at Point Mugu and at Point Arguello, 90 miles up the coast, seaward to Hawaii and Kwajalein, and inland to impact areas in Nevada and Utah.

In 1959, the Navy's missile testing function was separated from PMR for administrative and funding advantages, with the establishment of the Naval Missile Center as a separate command. Designated as the Navy's principal organization for the test and evaluation of air launched missiles, weapon systems, and related devices, the Center enjoyed continued growth in supporting developmental testing, Navy acceptance testing, production monitoring flight tests, and in-service engineering for deployed weapons. Utilizing PMR's well-instrumented

sea test range and its own state-of-the-art laboratories, the Center tested and evaluated a wide variety of current weapons such as Sparrow III, Bullpup, Sidewinder, Shrike, Walleye, and Phoenix.

The size of the Range was sharply curtailed in 1964 as inter-service realignments led to the transfer to the Army of two down-range sites and to the Air Force of the Navy facility at Point Arguello, tracking stations at Hawaii, and six highly-instrumented tracking ships. PMR retained a newly-developed underwater range at Hawaii and the missile range facility at Point Mugu, along with the offshore islands and one tracking ship.

The Naval Missile Center continued its growth, with a major portion of its effort going to support of the fleet during the war in Viet Nam. However, as hostilities tapered off and the Department of Defense share of the nation's budget was trimmed, fewer missile support programs were needed. Also, by this time the mission of PMR had become much more Navy oriented, and the potential for cost saving through recombining of local commands became evident.

Thus, in 1975 the Pacific Missile Test Center (PMTC) was established, combining the Naval Missile Center, the Pacific Missile Range, and as a subordinate command, the Naval Air Station. With a Fiscal Year 1976 budget of 214 million dollars, the Center operates on a matrix management system, with central project management being implemented through functional line organizations. (See Figure 1.)

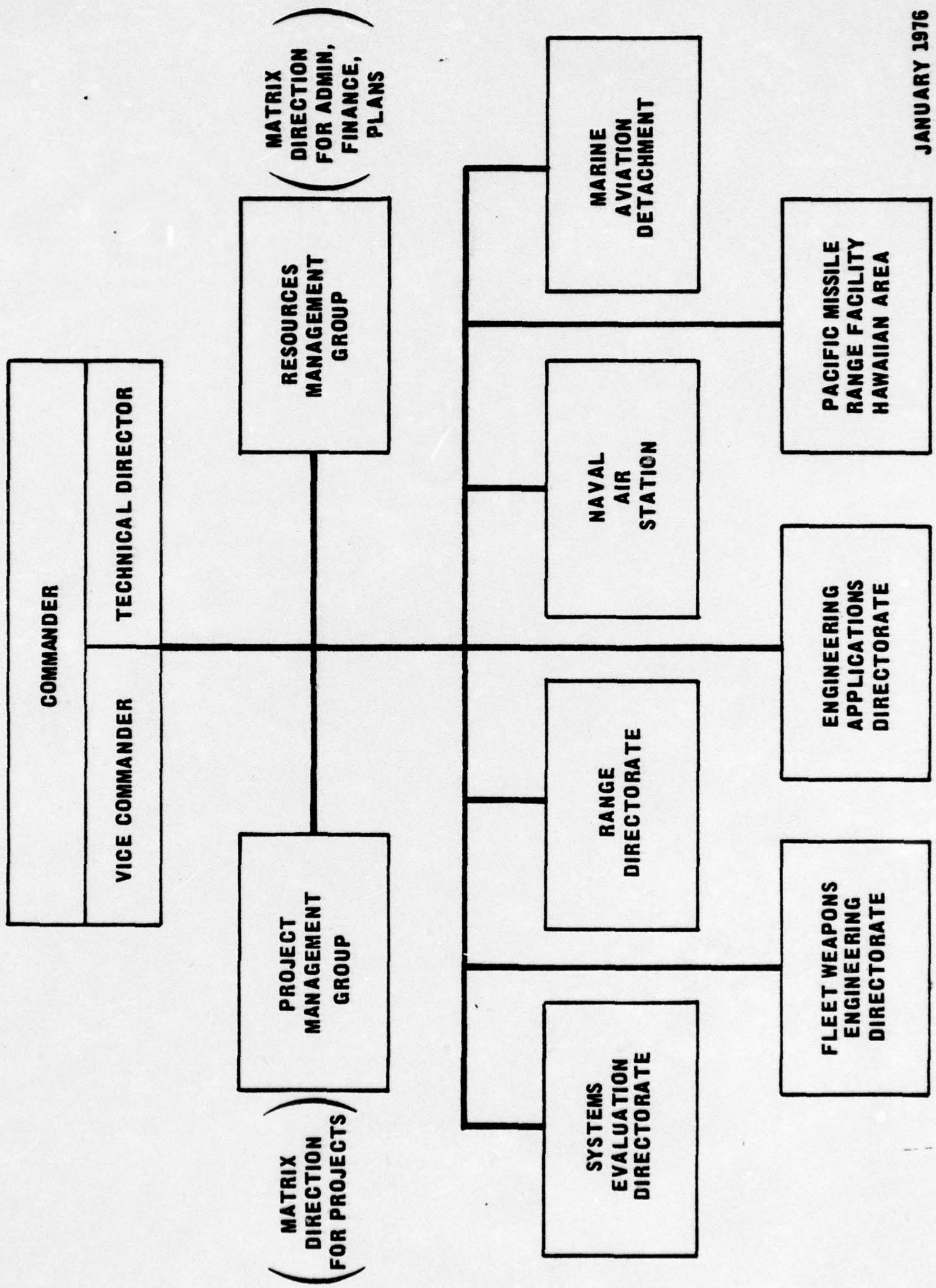

FIGURE 1

PACIFIC MISSILE TEST CENTER ORGANIZATION

The organization is comprised of two staff groups, four major engineering directorates, the Naval Air Station, the Pacific Missile Range Facility in Hawaii, and the Marine Aviation Detachment. Employment is approximately 900 military, 4400 civilian, and 1700 contractor.

Although operating once again as a single command, traces of the old structure remained, principally because of the funding systems employed. While about half of the organization operated under Navy Industrial Funding (NIF), the other half received institutional funds under the Resource Management System (RMS) accounting method. This caused inequities, in that RMS-funded departments charged only direct labor, their overhead being paid by institutional funding allocations, while NIF-funded departments charged, as in any commercial operation, for complete costs including overhead. This apparent difference in costs caused a shift in workload which had a serious effect on some departments. The situation was expected to be improved with revised accounting methods scheduled for implementation starting in October 1976. However, in his PMTC master plan [Ref. 2, p. I-31], the Commander sounded the warning that, looking to the future, "Organizations with high indirect costs will have to demonstrate their worth."

B. HISTORY OF THE DESIGN AND FABRICATION DEPARTMENT

The Design and Fabrication Department is the Center's central

facility for product design, manufacturing, equipment maintenance and repair, and calibration. Organizationally, the Department is one of three reporting to the Engineering Applications Directorate, Figure 1, with the other two being the Photography and Technical Information Department and the Instrumentation Department. Internally, the Design and Fabrication Department is organized as shown in Figure 2, with three principal line divisions, Design Engineering, Metric Engineering, Technical Shops, and one staff group entitled, "Resources Office."

The Department traces its history back to the earliest days of the Center, having undergone several changes in name, including Technical Service Department, Technical Support Directorate, Technical Support Department, and the present Design and Fabrication Department (D&FD). From its earliest days, its mission has been to provide design engineering services, maintenance, and repair in the fields of electronic, mechanical, and aeronautical engineering, and prototype manufacturing in these technical fields. This service was available to any of the other departments on the base and was occasionally used by other Government activities as well.

Typical of the jobs accomplished by the D&FD have been modifications of aircraft and the installation in aircraft of special test equipment, a ten-foot square oscillating table for the testing of shipboard weapon systems, communication system installations in missile control

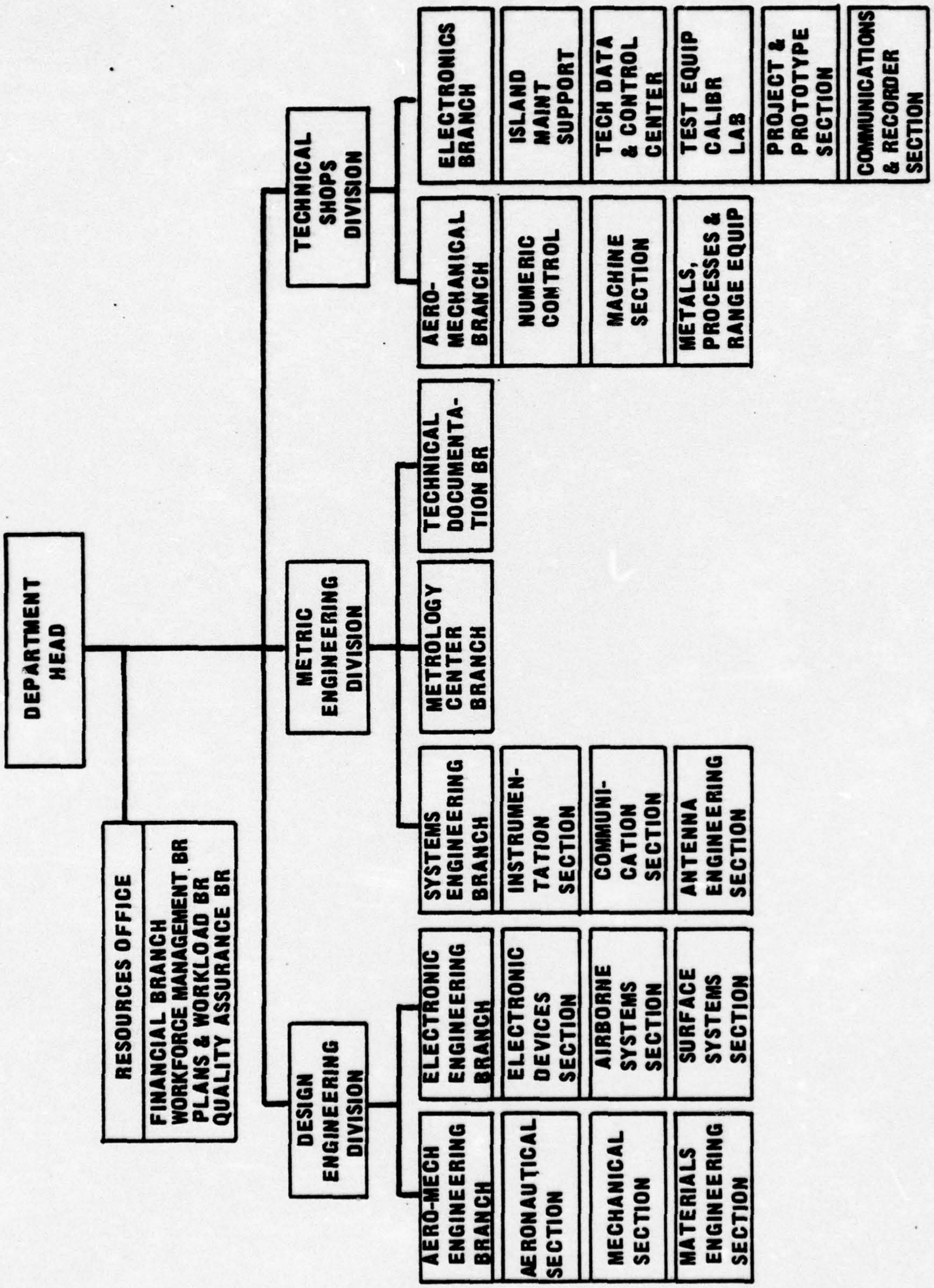

FIGURE 2

DESIGN & FABRICATION DEPARTMENT ORGANIZATION

areas, electronic control devices, and launch and retrieval devices for underwater torpedo-like targets. As an ongoing service, the D&FD does a considerable amount of repair, calibration and upgrading of electronic equipment, test equipment, and radar and telemetry systems.

The size of the Design and Fabrication Department has varied slowly over the years, having tapered off from a peak of about 550 during the 1960's to 369 in June of 1976. Facilities are scattered throughout several buildings, comprising about 166,000 square feet of floor space, including offices, manufacturing spaces, calibration laboratories, and antenna test facilities. Capital equipment is valued in the neighborhood of seven million dollars acquisition cost.

Until July 1975, funding for the Department had been from institutional sources. This provided the funds at the beginning of each fiscal year to sustain operations throughout the year. Customers were free to request services by initiating the standard PMR work-request documents. Only off-station customers were required to reimburse funds, and then only for direct labor and material. Work was so plentiful that a command-level priority control board was required to ensure optimum support over the entire center.

After the consolidation of the Center into PMTC, funding for the Design and Fabrication Department was changed to the Navy Industrial Funding system. It became necessary for customers to transfer funds from their own projects for each work request, and in addition to direct

labor and material, they were billed for overhead costs as well. This additional amount, which not only covered the Department's overhead costs, but also its share of the Directorate and Command expenses, was virtually twice the average direct labor rate. Where the customer previously had paid an average of ten dollars per hour for D&FD services, he now paid thirty. The total cost to the Government was the same; only the accounting procedures had been changed. But under the former institutional accounting system, the true cost had not been apparent to the user, leading to a "something-for-nothing" attitude.

To further complicate the funding picture, half of the Center remained on institutional funding, concerned with only direct labor and material charges. To many of the Department's potential customers, the full rate with overhead seemed excessive and they began to look elsewhere. Some turned to their own engineers for design work and to small shop facilities scattered throughout the Center, while others sent their work outside to contractors. This produced other side effects in complicating the interdepartmental delineation of functions and facilities.

The change in funding practices, coupled with shrinking Department of Defense spending, soon had its effect on the Design and Fabrication Department. The budget for FY1976, shown in Figure 3, was approximately twelve million dollars for direct labor, material, overhead (indirect) labor, and other overhead expenses for the Department. An additional three million dollars was budgeted for the Department's contribution to the Directorate and Command for general and administrative types of expenses.

COST
CENTER: DESIGN & FABRICATION COST CENTER 4100

PACIFIC MISSILE TEST CENTER
NIF COST CENTER OPERATING BUDGET

BUDGET
PERIOD FY - 76

	EXPENSE ELEMENT	ITEM	NAVAL INDUSTRIAL FUND COSTS							
			CIVILIAN MAN HOURS		CIVILIAN LABOR COSTS		MATERIAL	CONTRACTUAL SERVICES	OTHER	TOTAL COSTS
			REGULAR	OVERTIME	REGULAR	OVERTIME				
DIRECT		LABOR *	491,018	23,038	5,269,400	307,500	-			5,576,900
DIRECT		MATERIAL					1,878,400			1,878,400
DIRECT		CONTRACTUAL SERVICES						804,500		804,500
DIRECT		TRAINING	400		5,400				3,000	8,400
DIRECT		TRAVEL							102,000	102,000
DIRECT		OTHER								
DIRECT		TOTAL DIRECT	491,418	23,038	5,274,800	307,500	1,876,400	804,600	105,000	8,370,200
OVERHEAD	13	ADMINISTRATIVE SALARIES & WAGES	117,626	2,130	1,492,300					1,518,500
OVERHEAD	14	MISCELLANEOUS LABOR	72,041		552,900					552,900
OVERHEAD	15	STANDBY TIME	9,900		117,500					117,500
OVERHEAD	16	ALLOWED TIME	8,607		95,700					95,700
OVERHEAD	23	OPERATING SUPPLIES					312,600			312,600
OVERHEAD	24	MINOR EQUIPMENT					128,100			128,100
OVERHEAD	25	LOOSE & HAND TOOLS					43,800			43,800
OVERHEAD	31	CONTRACTUAL SERVICES						168,100		168,100
OVERHEAD	33	EAM ADP RENTALS						4,300		4,300
OVERHEAD	34	OTHER EQUIPMENT RENTALS						38,600		38,600
OVERHEAD										
OVERHEAD										
OVERHEAD	41	TRAINING	24,149		266,000				69,800	335,800
OVERHEAD	42	TRAVEL							17,300	17,300
OVERHEAD	43	PRINTING & REPRODUCTION					2,500	40,700		43,200
OVERHEAD	45	TELEPHONE SERVICES						10,000		10,000
OVERHEAD	46	INCENTIVE AWARDS			10,100					10,100
OVERHEAD	48	PCS BENEFITS							6,300	6,300
OVERHEAD										
OVERHEAD	51	ELECTRICITY								
OVERHEAD	52	GAS								
OVERHEAD	53	WATER – POTABLE								
OVERHEAD	55	STEAM								
OVERHEAD	57	SEWAGE DISPOSAL								
OVERHEAD	61	REPAIR & MAINT – BLDGS & GROUNDS						5,500		5,500
OVERHEAD	63	REPAIR, MAINT, & INSTALL – EQUIP & TOOLS	32,517		354,100		600	47,300		402,000
OVERHEAD	66	REPAIR & MAINT – FURNITURE & FIXTURES						3,100		3,100
OVERHEAD	67	ENGINEERING SERVICES						6,000		6,000
OVERHEAD	68	ALTERATIONS						42,500		42,500
OVERHEAD	70	BASIC CAPABILITY IMPROVEMENT	954		13,200		7,300			20,500
OVERHEAD	71	TECHNICAL PROFESSIONAL PROGRAM	977		7,900					7,900
OVERHEAD	72	MANAGEMENT INFORMATION SYSTEM								
OVERHEAD	74	EQUAL EMPLOYMENT OPPORTUNITY	906		11,400					11,400
OVERHEAD	79	LONG RANGE PLANNING								
OVERHEAD										
OVERHEAD		TOTAL OVERHEAD EXPENSES BEFORE TRANSFERS	267,681	2,130	2,921,100	26,200	494,900	366,100	93,400	3,901,700
OVERHEAD		NET TRANSFERS			(313,100)		(106,900)	(117,000)		(537,000)
OVERHEAD		TOTAL OVERHEAD EXPENSES AFTER TRANSFERS			2,608,000	26,200	388,000	249,100	93,400	3,364,700

FIGURE 3

FY 1976 BUDGET
DESIGN AND FABRICATION DEPARTMENT

As a result of the previously expressed customer reactions, the amount of incoming work did not meet expectations. Figure 4 shows how the direct labor hours spent on project work never met the budgeted figures, which had been projected from customer statements of desired support. Computations (Figure 5) were made from Figure 3 and Figure 4 data to compare the amount of direct labor as a percentage of total man-hours for each month, and the average for each quarter. As can be seen, direct labor dropped from a planned 66% of total labor to 46% for the first quarter, 45% for the second quarter, and 40% for the third. Management rightfully became extremely concerned.

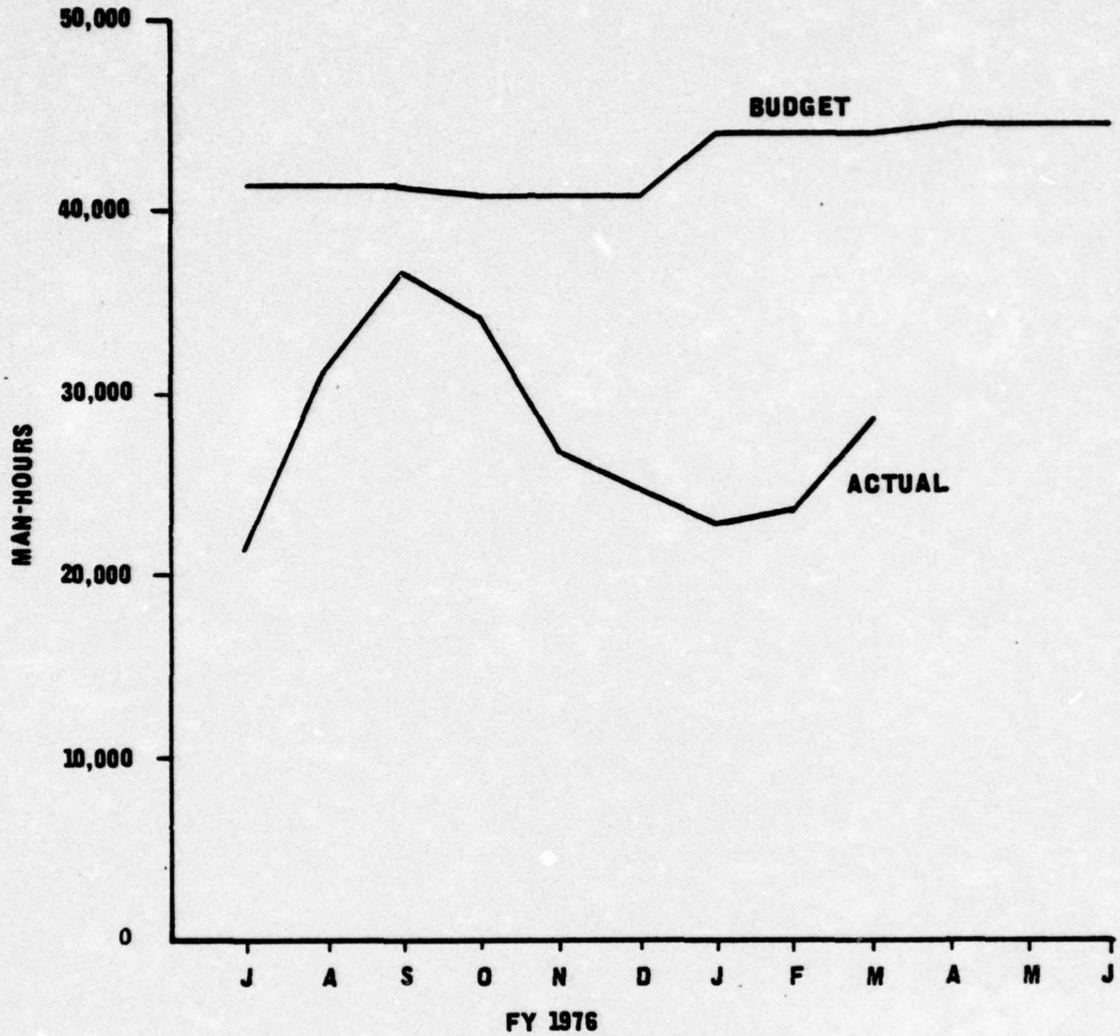

FIGURE 4

DIRECT LABOR IN SUPPORT OF PROJECTS
DESIGN AND FABRICATION DEPARTMENT

BUDGETED LABOR

DIRECT MAN-HOURS = (491,418+23,038) ÷12 = 42,871
(FROM FIGURE 3)

INDIRECT MAN-HOURS = (267,681 + 2,130) ÷12 = 22,484
(FROM FIGURE 3)

TOTAL MONTHLY MAN-HOUR BUDGET = 65,355

DIRECT LABOR AS PERCENTAGE OF TOTAL = 66%

APPLIED LABOR

MONTH	PERSONNEL AT START OF QUARTER	BUDGETED MAN-HOURS (ADJUSTED)	ACTUAL DIRECT MAN-HOURS	DIRECT AS PERCENT OF TOTAL	AVERAGE FOR QUARTER
JUL	410	65,355	21,459	33%	
AUG		65,355	31,109	48%	
SEP		65,355	36,699	56%	46%
OCT	396	63,123	34,183	54%	
NOV		63,123	26,481	42%	
DEC		63,123	24,704	39%	45%
JAN	390	62,167	22,884	37%	
FEB		62,167	23,899	38%	
MAR		62,167	28,467	46%	40%

FIGURE 5

DIRECT LABOR HOURS AS PERCENTAGE OF TOTAL
FY 1976

III. DESCRIPTION OF THE STUDY

Analysis of the changing conditions in the workload indicated that not only had the quantity of the workload diminished, but the nature of the work was changing as well. Whereas fewer work requests were being received in the design engineering fields, an important development had come about in the Metric Engineering Division with the establishment of a "Depot Level Maintenance" program for maintenance, repair and modification of radar and telemetry systems. Also, a Command-backed calibration program was developing that would have a positive impact on the Calibration Center.

Another condition found was that the individual line organizations were soliciting their own work. While this did indeed bring in some additional work, it had caused other problems. Accounting measures and priority guides began to lose their central control. Shops management established its own completion dates and the Depot Level Maintenance program established its own accounting numbers. Conflict and confusion resulted.

This study, sponsored by the Department Head, attempts to analyze the organization operations and suggests means of neutralizing some of these problems.

The first step of the study was to interview each of the personnel in the Plans and Workload Branch. For this purpose, an interview

form, Appendix A, was developed. The sessions typically lasted about an hour and were quite productive, yielding not only organizational duties, but also a number of positive suggestions regarding improvements in department procedural operations.

Next were interviews with supervisors and managers in the three line divisions which the Resources Office serves, and for this, another form, Appendix B, was developed. All supervisors in the Design Engineering Division and the Metric Engineering Division and several in the Technical Shops Division were interviewed, with the purpose of defining how the services of the Plans and Workload Branch were being utilized and how these services might be improved.

In a third series of interviews, managers of somewhat similar facilities were visited to determine what methods were being used elsewhere, both in the Navy and in private industry.

Literature searched included current textbooks, library reference books, articles from business periodicals, and reports from the Defense Documentation Center. This material was blended together to formulate a detailed picture of the present operation and several proposed alternatives for improvements.

IV. ANALYSIS OF THE ORGANIZATION

A. FUNCTION OF THE PLANS AND WORKLOAD BRANCH

The Plans and Workload Branch is primarily responsible for receiving incoming work requests, coordinating priorities, coordinating assignment of cognizance to the proper engineering section, managing tasks for which no engineering is required, and assisting in the procurement of manufacturing materials. With approximately twenty-two positions, the Branch is divided into two main parts, the Project Workload Section and the Maintenance Workload Section, and one small group, the Contracts and Materials Section (see Figure 6). At the time of the interviews, each of the two major sections had three subgroups of skills in addition to a clerk-typist. The most influential sub-group, the Production Controllers (informally called Planner-Estimators), work very closely with people in the engineering divisions, assisting the engineering task executives. They also manage a number of tasks for which no engineering is required. A smaller sub-group of Production Controllers, usually referred to as Schedulers, work closely with the Technical Shops Division supervisors and planners, coordinating shop inputs directly with requestors on minor jobs and with the Planner-Estimator on major jobs. The third and smallest sub-group, the Production Dispatchers, assists the Planner-Estimators and the

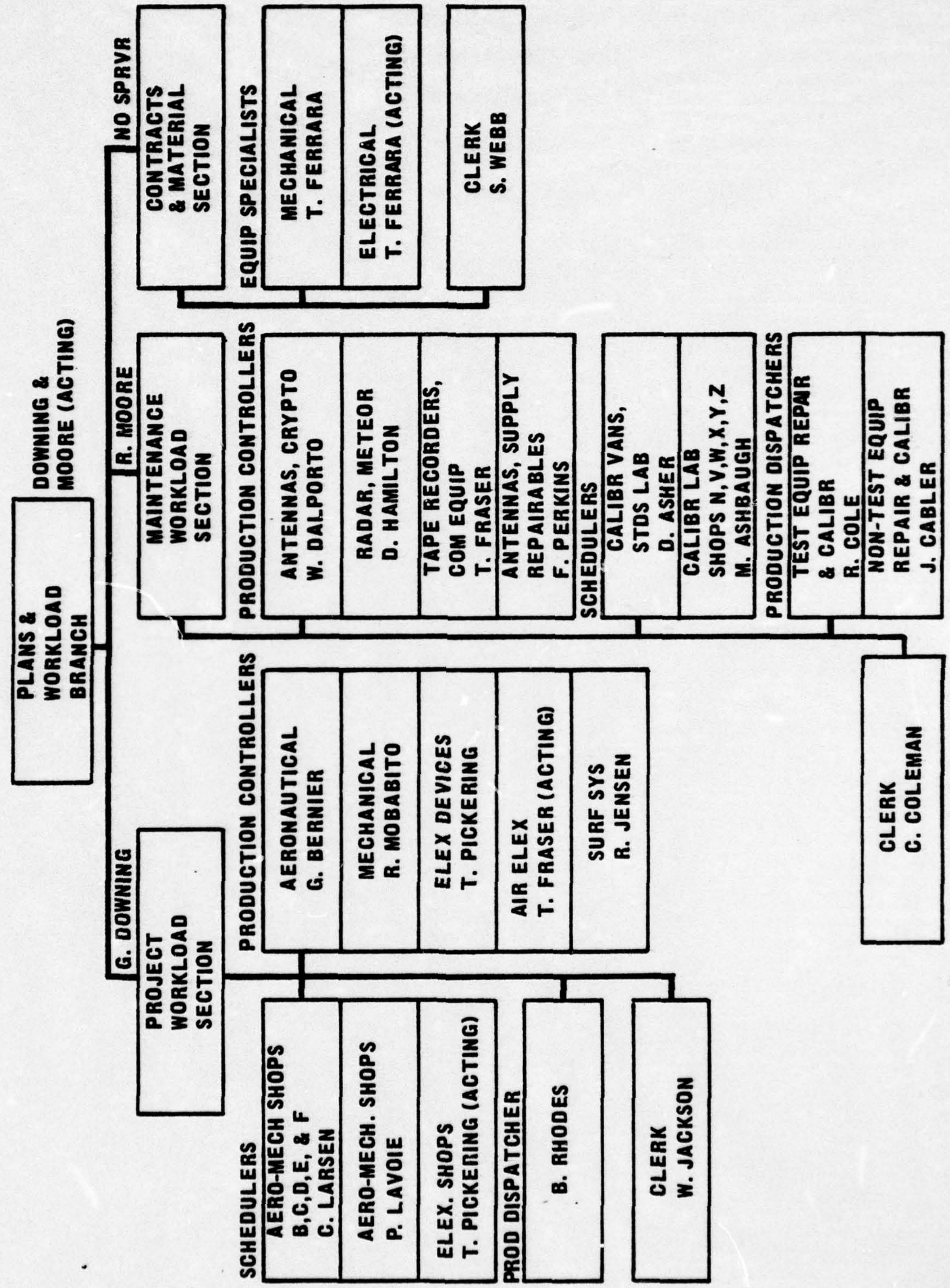

FIGURE 6

ORGANIZATION OF PLANS AND WORKLOAD BRANCH

Schedulers by pick-up and receipt of equipment for repair and calibration from customers, making truck pick-ups on emergency material purchases, and delivering completed products. Division of work between the two sections is based on the relative involvement of the two engineering divisions. The Contracts and Materials Section coordinates the processing of material requests and contract requests between the Design and Fabrication Department and the Supply Department, and performs follow-up action as requested. A few months earlier, it had been staffed by two equipment specialists and one clerk, but at the time of the interview it was down to only one equipment specialist and one clerk. Except for clerical support, the Section serves principally the Project Workload Section, where the members report for supervision. The clerk types material forms, serves as the Resources Office Timekeeper, and assists the work order processing clerk in the other two sections. Formerly one equipment specialist did materials requisitioning follow-up for the Maintenance Workload Section, but recently the Maintenance Production Controllers, in order to eliminate processing steps began doing their own materials recording and follow-up. As a result, one of the equipment specialist positions was eliminated on a trial basis. However, that function should be observed closely, because accelerating NIF materials accounting requirements could create a need for that position to be reinstated.

B. TASK MANAGEMENT IN THE DESIGN AND FABRICATION DEPARTMENT

For all incoming work, the head of the Plans and Workload Branch talks with the requestor, assesses the task, reviews the adequacy of work request documents, checks to see if prior contact has been made elsewhere in the Department, and looks for any other salient features. By copy of the work request, he initiates action in the Financial Branch, where accounting information is coordinated with the PMTC Comptroller and the requesting department financial staff.

Assignment of the person responsible for task direction and performance, the task executive, is coordinated by the Plans and Workload Branch Head. This is a critical process since two distinct methods of task management are used. If engineering work is part of the task, responsibility for the task is given either to the Design Engineering Division or the Metric Engineering Division. But if manufacturing is the principal requirement and engineering is not required, responsibility remains in the Plans and Workload Branch. Often the decision is obvious, but if not, it is made by the line managers in the engineering divisions. Once this basic choice has been made, the engineering line managers select one of their personnel as a task executive, and for manufacture-only tasks the Plans and Workload Branch Head selects one of his production controllers to serve as task executive.

Thus two distinct methods for task management have evolved; one led by an engineer in a line division, and the other led by a production

controller in a staff office. As a further complication, these same production controllers who manage tasks of their own, also assist the engineers in prosecuting their tasks by issuing blueprints and shop instructions, ordering manufacturing materials, and coordinating priority problems. This dual method of task management was one of the key features to be resolved by the study.

C. ACCOUNTABILITY IN THE DESIGN AND FABRICATION DEPARTMENT

Having thus been given the authority for managing the new task, the task executive leads it through to completion. He has considerable freedom in deciding methods of accomplishing the work, and should the nature of the product require design expertise in other fields, he can request assistance from technicians and draftsmen in his own group as well as from engineers in other groups. A design team is formed, cutting across organizational lines within the Department in a matrix manner.

The assisting engineers serve as sub-task executives, issuing and monitoring production in their own specialty areas. However, it is still the task executive who is held accountable for completion of the entire job. In this capacity, he serves much as a staff assistant to the Department Head and carries a commensurate amount of authority.

One of the problems uncovered, however, was that accountability was not clear in the Design and Fabrication Department. Some task

executives felt that they were responsible only to the requestor in another department and not to their own chain of command. Still others felt that establishment of priority ratings by the Command-level priority control board relieved them of all responsibility for timely completion of their tasks. Clarifying this situation was another principal item to be addressed.

Organizational concepts taken from the literature and which are applicable to the Design and Fabrication Department are reviewed in the following chapter.

V. ORGANIZATIONAL CONCEPTS FROM THE LITERATURE APPLICABLE TO THE DESIGN AND FABRICATION DEPARTMENT

The task executive's authority is very similar to that described by Henry H. Albers [Ref. 3, p. 113] in delineating line and staff relationships in a military environment. He suggests that the idea that the line officer commands and the staff officer does not command is not descriptive of the true situation. Although a line commander is formally required to respond only to commands from a superior line officer, he obviously cannot ignore the superior's staff officers. Suggestions from higher level staff officers are rarely taken lightly. Further, he maintains, every line commander knows that a staff officer's suggestion can be followed by a formal order in the name of the superior commander, so that even a staff officer of low rank may have considerable influence if he comes from headquarters. In the same manner, the task executive carries substantially more authority than would be associated with his normal position of design engineer.

In spite of the freedom that goes with the task executive's responsibility, he is still held accountable by the Department Head through the line management chain. The first level supervisor gives the task executive wide latitude in accomplishing his assignment, but reserves the right to intervene under appropriate circumstances. This is very much as Joseph A. Litterer [Ref. 4, p. 642] describes the practice of

"override." He maintains that, although higher management can delegate responsibilities, it cannot transfer them, and so the ultimate responsibility is always retained at the higher level. Essentially the same concept holds true for authority. Even though certain authority is designated for lower executives, the higher executive always has the final authority. He further points out that even in a decentralized organization where lower executives have a great deal of autonomy and independence, the exercise of their authorities is always subject to an override by higher executives.

This concept of a higher, usually latent, overriding authority provides a useful organizational notion. It is different from the more common concept of management, wherein the lower executive refers problems to higher authority for decisions and actions. Under the override system, the task executive may act quite independently in pursuing his objectives, but if problems are referred by others to his supervisor or the Department Head, the task executive is held accountable for his actions.

Numerous references in the literature are found relating to organizations not unlike the Design and Fabrication Department. An overriding theme is that no one method of organizing is the ideal for every situation. Each structure must be tailored to the individual set of circumstances and group of employees encountered in the organization. However, studies of the literature help to clarify the

definition of labels and lead to a better understanding of similar functions in different organizations.

In determining how a manager chooses among organizational design alternatives, Michael B. McCaskey [Ref. 5] defines some of the basic principles. Organizational design, he relates, determines what the structure and process of an organization will be. The features of an organization that can be designed include: division into sections and units, number of levels, location of decision making authority, distribution of and access to information, physical layout of buildings, types of people recruited, what behaviors are rewarded, and so on. In the process of designing an organization, managers invent, develop, and analyze alternative forms for combining these elements. And, as Herbert A. Simon [Ref. 6] points out, the form must reflect the limits and capabilities of humans and the characteristics and nature of the task environment.

Designing a human social organization is extremely complicated. An organization is a system of interrelated parts such that the design of one subsystem or of one procedure has ramifications for the other parts of the system. Furthermore, the criteria by which a system design is to be evaluated cannot be maximized simultaneously. The design will never be perfect or final. In short, as McCaskey concludes, the design of organizational arrangements is intended to devise a complex set of trade-offs in a field of changing people, environment, and values.

But proper organizational structures do not simply evolve. The right structure, or even a livable structure, as Peter Drucker [Ref. 7, p. 523] describes it, is no more intuitive than were the Greek temples or the Gothic cathedrals. The first step, he emphasizes, is not designing the structure. Rather it is to identify and organize the building blocks of organization, that is, the activities which must be encompassed in the final structure and which, in turn, carry the structural load of the final edifice. It is not enough to clasify them in the traditional way of "staff and line." Like all materials, these building blocks have their specific characteristics. Depending upon each set of circumstances, they belong in different places and fit together in different ways.

In the matter of determining the distinction between line and staff, William Sexton [Ref. 8, p. 67] stipulated that the difference between line and staff is the assignment of roles. Any time two or more people work together, he maintains, this distinction is a means of determining who makes decisions directly related to the attainment of end results and who provides advice and service in making those decisions. According to Sexton, "Line refers to those positions and elements of the organization which have responsibility and authority and are accountable for accomplishment of primary objectives. Staff elements are those which have responsibility and authority for providing advice and service to the line in the attainment of objectives."

In explaining two distinct functions of staff, Litterer [Ref. 4, p. 585] states, "One part of the typical concept holds that the function of staff is to assist the executive in a variety of ways in performing duties that he would otherwise have to do himself .... A second part of the general staff concept is for the staff to supply special knowledge, skill, and the like, needed by an executive." The former part of this definition, performing duties that the executive would otherwise have to do himself, helps to explain why a staff person sometimes appears to have line authority, just as is found in the Plans and Workload Branch, where the production controllers sometime serve as task executives in directing a task. That this function should be line in nature is argued by Robert C. Sampson [Ref. 9, p. 44].

> Clearly, staff people cannot have operating responsibilities. Hence, they cannot participate in deciding, doing, or controlling, in finance, production, or sales. If they do, they interfere with line management's right and responsibility in decision making. Nor can staff people issue orders directly or indirectly to line people through setting policy, devising standards, or prescribing methods. If they do, they are taking a line action and interfering with line superior-subordinate relationships ....

In further clarification of the direct line of authority, a definitive case was noted in the Organization Manual of the Naval Air Test Center, Patuxent River, Maryland [Ref. 10, p. TSD-3]. The Technical Support Directorate is headed by a naval officer. Directly under him, in line, is the Technical Director, a civilian. Under him are two staff groups and four line branches. Some of the duties of the Technical Director are:

. . . . . Responsible for the technical quality of the work of the Directorate . . . Acts as Technical Support Directorate liaison contact . . . . Responsible for preparation of the budget and administration of Directorate funds . . . . Assigns projects to the appropriate branches and coordinates their efforts.

Another area to be considered in the problem of designing organizations arises from the choices available among alternative bases of the authority structure. The most common way is to group together activities which bear on a common product, common customer, common business function, or common process. Each of these bases has various costs and economies. For example, the functional structure facilitates the acquisition of specialized inputs, such as engineers in a variety of disciplines, by sharing them across products or projects. This feature is very important if the organization is going to develop high-technology products.

However, this approach has its shortcomings. As described by Jay Galbraith [Ref. 11, p. 30], the tasks that the organization must perform require varying amounts of the specialized resources applied in varying sequences. With the functional structure, fully utilizing these specialist resources and also completing all tasks on time is all but impossible. On the other hand, the product or project form of organization has exactly the opposite set of benefits and drawbacks. It facilitates coordination among specialties to achieve on-time completion and to meet budget targets. But if each project requires the use of engineering specialists on a less than full-time basis, each

must hire its own engineers and thereby incur duplication costs. In addition, nobody is responsible for long-run technical development of the specialties. Thus, each form of organization has its own set of advantages and disadvantages. Managers usually make a judgement as to whether a technical development or schedule completion is more important and chose the appropriate form.

Galbraith further points out that aerospace firms faced a situation in the space program of the 1960's where both technical performance and timely completion were important. One result, which attempts to combine the benefits of both types of organization, was the matrix form of organization. Shull and Judd [Ref. 12, p. 65] describe the matrix *in its most elementary form* as a cross-hatch of structural elements, with discipline or functional units forming the vertical dimensions, and product or project units providing the horizontal dimensions. The underlying rationale of the matrix structure, as explained by J. L. Gray [Ref. 13, p. 73-82], is that objectives are best met if the organization's resources can be oriented toward those objectives without regard to traditional hierarchical constraints. The organization structure is viewed as a means to an end and can readily be adapted to a changing environment. Whereas bureaucracies are organized around functions and hierarchical positions, matrix organizations are organized around problems or projects and the person who has the expertise relevant to the problem.

Diagramatically, the basic matrix organization is represented by the chart of Figure 7, adapted from Chris Argyris [Ref. 14, p. 18-23]. It shows how project teams can be composed of members from various functional groups, with the team leader being selected as the most appropriate for the particular task. Since resources are organized around specific projects, the organization is continually changing as projects are completed and resources are deployed to new or other current projects.

The usefulness of the team approach is further underscored by Drucker [Ref. 7, p. 569] as he states that the area where team design as a complement to functional organization is likely to make the greatest contribution is in knowledge work. The knowledge organization is likely to balance "function" as a man's "home" with "team" as his "place of work." The functional organization also has a challenge in maintaining a level workload to keep the staff meaningfully occupied and to retain qualified people. This is especially true in the Government, compared to private industry, as there is little freedom to expand or contract in meeting changing workload conditions.

This challenge requires better functional management. There is great need for concern with, and management of, the specialists themselves. Do they work on the truly important things, or is much of their time wasted? Do they do over again what they already know how to do, or do they work on creating new potential and new performance

REPRESENTATIVES OF	PROJECT 1	PROJECT 2	PROJECT 3	PROJECT N
FUNCTION 1	MEMBER		LEADER	
FUNCTION 2	LEADER	MEMBER		
FUNCTION 3			MEMBER	
FUNCTION 4	MEMBER	MEMBER	MEMBER	LEADER
FUNCTION N		LEADER		MEMBER

FIGURE 7

BASIC MATRIX ORGANIZATION

capacity? Are they being used productively, or are they just being kept busy? And are they being fully developed as professionals and as persons?

As for the technical expert in a functional group being effective in leading a task, it was found by Dalton, Lawrence, and Lorsch [Ref. 15, p. 11] that in all the high-performing organizations, the individuals primarily involved in resolving conflicts, whether they were a common superior in the hierarchy or persons in special integrating positions, had influence based to a large extent on their perceived competence and knowledge. This was in contrast to the less effective organizations where such persons usually drew their power solely from their positions or from their control over scarce resources. Reasons such as these might well explain the effectiveness of many of the engineering task executives in the Design and Fabrication Department even though their authority is not clear on the organization chart.

In further clarifying the matrix concept, Galbraith [Ref. 16, p. 127] gave the following description of a central office for the control of products or programs, the Program Manager's Office:

> This group collects information for the general manager and aids in the integration of the functions. In addition, the program manager maintains information needed by Marketing and represents the Branch to the customer. The Program Manager chairs a committee consisting of the functional scheduling groups and Marketing. This committee decides on internal start and finish dates for each customer order. These dates become the schedule that handles the second-order sequential interdependence. Then each group breaks out more detailed schedules for start and finish dates within each function.

Central control such as that described above by Galbraith was not utilized in the Design and Fabrication Department. Instead, control had been spread on an individual task basis to the various functional engineers, and the higher line managers were often little concerned with most of the tasks.

This division of the task executive's responsibility between functional effort and program management was an important point with Peter Drucker [Ref. 7, p. 570]. He relates that the knowledge organization will increasingly have two axes: a functional one, managing the man and his knowledge; and the other one the team, managing work and task. While this saves the functional principle and makes it fully effective, it certainly requires strong, professional, effective, functional managers. It is the key, in all probability, to making functional skill fully effective in the knowledge organization.

VI. OBSERVATIONS FROM OTHER INDUSTRIAL FIRMS

In order to compare recommendations from the literature with what is actually being used in practice, several industrial firms were visited and their organizational structures studied. Following is a listing of these visits:

1. L. M. Dearing and Associates, Studio City, California; a small manufacturing and sales company dealing in electronic timing devices for Navy instrumentation cameras and in solar heating devices.

2. McDonnell Douglas Astronautics Company, Huntington Beach, California; missile manufacturing and instrumentation.

3. Naval Weapons Center, China Lake, California; Engineering Prototype Division of the Engineering Department; manufacturing of prototype equipment and missile components.

4. Northrop Corporation, Ventura Division; Newbury Park, California; manufacturer of pilot-less aircraft missile targets, underwater targets for torpedos, and aircraft sub-assemblies.

5. Raytheon Corporation, Oxnard Facility, Oxnard, California; manufacturer of test equipment and missile components.

A representative visit is described below, but for more detail an account of what was found at each location pertaining to the study has been included as Appendix C.

Typical of the organizational structure found most often was that of Raytheon's Oxnard Facility, shown in essence in Figure 8. Rather than utilizing team leaders in the various functional departments, such as was done in the Design and Fabrication Department, Raytheon brought all of them together into a separate line group called the Program Office, which reported directly to the plant manager and was considered to be on an equal level with the operating functional departments. The program manager was in charge of a project from the time a request for quote was first received until the finished product was delivered. He coordinated the estimate with the functional departments, prepared overall schedule charts, and issued work orders to each of the departments. The department heads did their own planning and scheduling within the overall plan and, having participated in the original estimate, felt committed to the cost and time estimates.

Common to all the firms visited was this sense of commitment felt by the line managers in supporting the programs. Another salient feature, demonstrated in the Raytheon system, was that most program managers reported to the same supervisor, thereby providing the effective guidance shown in the prior section as being extremely important to Peter Drucker.

In summary, these findings from industrial practice, together with those from the literature and the in-house interviews, form the basis of the alternative recommendations that follow.

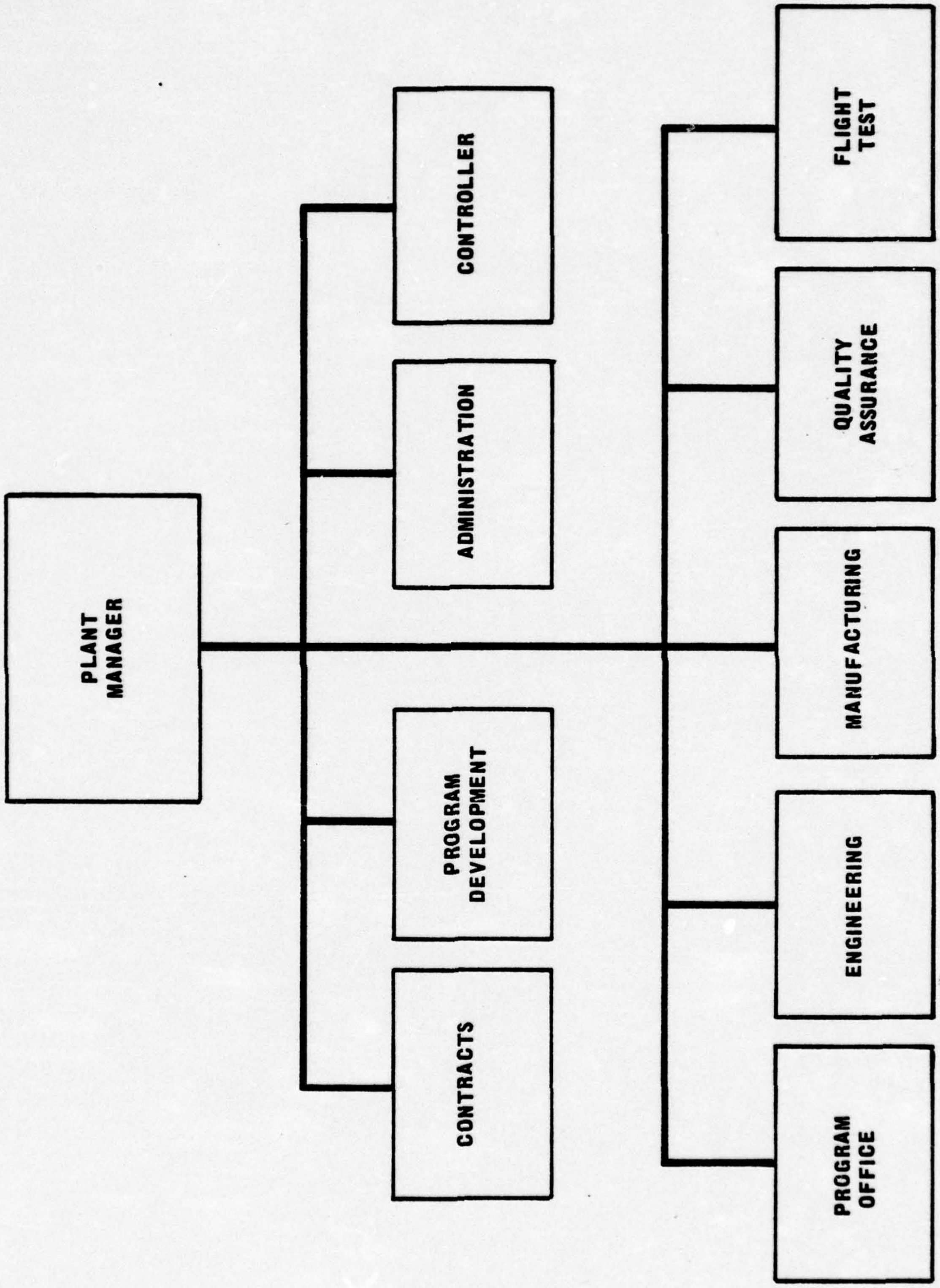

FIGURE 8

ORGANIZATIONAL STRUCTURE AT RAYTHEON, OXNARD FACILITY

VII. PROPOSAL FOR REORGANIZATION

A. DESCRIPTION OF ALTERNATIVES

The alternatives were developed with the goal of providing a more uniform system of responsibility and accountability, one which would increase the economy of operation. Though the study was originally addressed only to the Resources Office, the proposals soon encompassed the three line divisions. A number of alternatives were developed in order to give the Resources Officer and the Department Head more freedom in selecting the appropriate action.

Listed in order of scope and impact on the organization, the alternatives are given below:

1. Consolidate Plans and Workload Branch

As a very basic step, the Plans and Workload Branch should be consolidated under one supervisor. At the time the interviews were made the Branch contained three sections. One had only two people in it and had no supervisor. The other two were larger and similar to each other with one supporting the Design Engineering Division and the other supporting the Metric Engineering Division. Only one section had a full-time supervisor, and it was likely that he would be retiring soon.

The production controllers (planner-estimators) already did very similar work, but supported different engineering divisions. Consolidation would allow the supervisor to shift manpower more readily

as required by changing workload and to combine filing systems and clerical support. That a need for this kind of flexibility was already apparent is shown by the awkward assignment of a man from one section to do work for both sections, giving him, in effect, two supervisors. Consolidation could provide more uniform application of training received by Branch personnel. For example, some have received specialized training in planning and preparation of procurement packages, and the Department might well benefit if this information were disseminated and used more uniformly throughout the Branch.

Schedulers and production dispatchers could also be reassigned as the need arose. As a further advantage, one or both of the equipment specialist positions could be eliminated if the present experiment proves successful in having the planner-estimators process their own material requests.

Since the Branch Head was already personally supervising most of the Branch personnel and the total workload was less than in previous years, an improved and more economical operation would be obtained by not replacing the one section head when he retires and consolidating the entire group under the one branch head.

2. Reassign Schedulers and Production Dispatchers

In addition to the above recommendation, the schedulers should be reassigned to the manager they most closely support. Although the schedulers were assigned to the Plans and Workload Branch, their

primary duties were to receive and schedule work for the Technical Shops Division, where they also were physically located. Since the scope of their work was limited to supporting the Technical Shops, they should report to that division head. This would place the schedulers organizationally next to the manager they supported and at the same time emphasize the position of the line manager as being responsible for accomplishment of work assigned to his division.

The production dispatchers worked principally as assistants to the schedulers, mostly in the handling of incoming or outgoing equipment and material. This relationship was effective and so it should be continued, with the production dispatchers being reassigned along with the schedulers.

3. Reassign Planner-Estimators

As a further step, reassignment should also be made of the planner-estimators to the line managers they serve. The planner-estimators were the most influential members of the Plans and Workload Branch, having contact with requestors, coordinating priorities, and issuing work to the schedulers. Their scope of responsibility and operation was in two distinct modes. As mentioned earlier, tasks with no engineering were assigned to planner-estimators as task executives, while tasks on which engineering was required were assigned to engineers in the line divisions, with the planner-estimator serving as an assistant. This dual method of operation often led to confusion as to whether control

was in the staff Resources Office or the line divisions. Reassignment of the planner-estimators to the engineering divisions would allow accountability for all tasks to be vested with the same line managers. First-level supervisors would be able to assign tasks to either an engineer or a planner-estimator and would be knowledgeable of all work in his field. The basic matrix of Argyris, previously shown in Figure 7, would have maximum utility, as teams could be formed readily for any nature of task. The head of the Plans and Workload Branch would become the Workload Coordinator, receiving all incoming work requests, coordinating receipt of funding with the Financial Branch, assigning tasks to the appropriate engineering division, and resolving priority conflicts with requestors.

4. Establish Marketing and Liaison Office

A marketing and liaison office should be established to improve inter-departmental relations. This alternative would eliminate the Plans and Program Branch by effecting the described reassignments and replacing the workload coordinator, whose duties would be assumed. This office would be responsible for selling department services to customers both within and outside of the Pacific Missile Test Center. In his marketing capacity, the head of this office would serve as the Department's prime public relations specialist, and in his liaison capacity would serve as a customer relations specialist, coordinating special customer needs with appropriate division heads. Long-range planning,

contract administration, and the management information system could also be centrally located in this office. Because of the broad nature of the responsibilities, it would be important to have the office headed by a senior engineer with a broad background. This alternative, in addition to the prior steps, would help to project the department image.

5. Establish Product and Program Management Division

As the most sweeping alternative, a Product and Program Management Division should be established. While similar to the above proposal, this alternative would make the function clearly established as a line division rather than as a staff office. The division would have coordinating, directing, reporting, and financial responsibility for all tasks (electronic, aeronautical, mechanical, calibration, maintenance, and quality assurance). Execution of the tasks would remain in the other three divisions.

This alternative would incorporate the principal features of the preceding proposals, except that the marketing function would be assumed by the division head, and the liaison function would be assumed by the individual managers.

One of the principal advantages of this structure would be a clearly defined central authority that could speak for any function in the Department. Also, the Department's one continuing program management function, depot level maintenance of radar and telemetry systems, would be raised to a more visible level in the Department.

A possible disadvantage, on the other hand, would be the addition of another link in the chain of communications. It would, however, give a structure very similar to what has found widespread acceptance in industry.

B. THE PERCEIVED NEEDS OF THE DEPARTMENT

Throughout the interviewing process, the needs of the Department expressed most often were twofold. First was a desire to see a unification of the Department's objectives and operations, and second was a re uction of the Department's overhead rate in order to be more competitive.

Fragmentation of the Department's efforts had been sensed by many as placing one group from the organization in competition with another, to the detriment of the whole. As workload had tapered off, marketing for new work had been done on an individual basis with varying degrees of success. While this was helping to keep more skills properly utilized, the feeling was prevalent that work was being guarded jealously and not being accomplished in the most efficient manner.

A large staff at the Department level was seen by many as adding more than necessary to the overhead rate. Most felt that the functions accomplished by the Resources Office were vital to the operation of the Department, but might be accomplished more efficiently under the direction of a cost-conscious manager in a line division. And as a side benefit, distribution of staff people to the line organizations would dampen outside criticism of a large staff group.

C. RECOMMENDATIONS FOR THE DEPARTMENT

In considering what would be best for the long-term health of the Department, consideration was also given to the present climate, as expressed in the interviews. Some of the ideas formulated in the alternatives were perhaps too far-reaching, considering adverse reaction to program management attempts in other sectors of the Center.

Accordingly, two of the alternatives are emphasized for management consideration. First, for moderate improvement with only minor shifting of personnel, alternative 2 is recommended, involving consolidation of the Plans and Workload Branch and reassignment of the schedulers and the production dispatchers to the line divisions. Second, if a more extensive reorganization is acceptable, then alternative 4 is considered best, with the establishment of a marketing and liaison office. But if it becomes impossible to establish the engineering manager position as recommended, then an acceptable fall-back position would be alternative 3.

Accountability was considered of paramount importance in any reorganization plan. It seemed essential that task executives and their supervisors should be held accountable for the technical, financial, and managerial control of their tasks, and that this responsibility should extend directly upwards through the line managers to the Department Head.

Control was the other feature essential to the plan. It was felt that managers needed the freedom to schedule operations in their own area

within an overall plan, but without the detailed dictates of a staff person, someone who is outside of his own chain of command. Assistance by scheduling specialists was considered appropriate, but it is the line manager who should have the control and be held accountable.

Both of the recommended alternatives, number 2 to some extent, and especially number 4, would make long strides towards obtaining effective accountability and control. And as a long-term gain, even the taxpayers should benefit from a more economical operation.

APPENDIX A

INTERVIEW FORM FOR PLANS AND WORKLOAD BRANCH

NAME_______________________ POSITION_______________________

1. FUNCTION

   a. What is your function as you see it? Proportion of time in each area?

   b. What do you believe is the most important purpose of your own job functions?

2. WORKFLOW

   a. Do your work assignments come from your immediate supervisor?

   b. If not, from whom?

   c. Do day-to-day inputs to your job come via your supervisor, from someone else in the Department, or someone outside the Department?

   d. Who is the user of your services?

   e. Do you ever feel your supervisor has been by-passed when inputs come directly to you?

3. FUNCTION FOLLOWUP

   a. What are some other responsibilities of your position?

   b. What do you think is the overall purpose of having your branch?

c. How does your function fit in with the purpose of your Branch?

d. Are there others in the Department who seem to be doing work that should be done by you?

e. How has the priority-by-completion-date been working?

f. How adequate is the response to your instructions by other areas in the Department?

g. Would your instructions have more impact if they were endorsed by a line manager? How?

h. Do you feel that a task executive from Planning has the same influence as a task executive from either engineering division?

i. Would your position of influence be improved if you were staff to one of the engineering divisions directly?

4. IMPROVEMENT: Do you have any suggestions for improving operations - - - -

a. Your function?

b. Others' functions?

5. FUNCTION FOLLOWUP: What are some of the other important functions of your job that we might have missed?

6. M.I.S.: What type of management information systems reports would be helpful to you?

APPENDIX B

INTERVIEW FORM FOR SUPERVISORS AND MANAGERS

NAME ____________________ POSITION ____________________

1. How do the Financial Branch and the Plans and Workload Branch presently support you and the organization under you?

2. How might they better support you?

3. What person or persons within those branches most directly support you?

4. What advantages/disadvantages would you see from relocating these persons under your direct supervision?

5. We would like to visit industries with similar operation to ours. Any suggestions?

APPENDIX C

OPERATION AT OTHER ACTIVITIES

1. L. M. Dearing and Associates. This was a small firm in Los Angeles that had prospered by developing instrumentation devices, principally for the Navy. In recent months, they had utilized in-house talent to develop solar heating devices, enabling them to diversify into a lucrative commercial venture. A manager was over each of the divisions, but Dr. Dearing ran the business very much as an individual entrepreneur.

2. McDonnell Douglas Astronautics Company. Located at Huntington Beach, California, this division of the McDonnell Douglas Corporation was established for the design, development, manufacturing, and testing of missile systems. Some of their more well-known products include the Nike anti-aircraft missile, the Thor ballistic missile, the Delta satellite-launch missile, and the S-IV-B upper stage for the Saturn launch vehicle for the *Apollo* space program.

Most of the McDonnell Douglas programs were rather large, enabling the company to utilize the matrix method quite effectively. A key person from each of the functional departments was selected jointly by the program manager and the functional manager, and he then became part of the program management team, actually moving his work station to the team location for the duration of the program. This added to the cohesive team feeling but still maintained the tie to the individual's functional department, with which he would be coordinating major work efforts.

For the largest of programs, a more permanent arrangement was employed. A project team was formed, with all the required personnel being hired or transferred to the program manager's payroll. A senior member of the firm, very likely a vice-president, would be in charge of the program, at an organization level parallel to the vice-president in charge of the managers of the smaller programs.

3. Naval Weapons Center. At NWC, China Lake, the Engineering Prototype Division visited was very similar to the Design and Fabrication Department's Technical Shops Division. This division (consisting of 115 manufacturing-type employees) included an extensive machine shop, sheet metal, welding, heat treating, and plating shops, and a small electronic shop facility. Although they were found to be operating at low capacity, this shop, with some of its present members, had in

earlier days accomplished the experimental and first production manufacturing of the Sidewinder missile. At the time of the visit, they were manufacturing only a wide variety of minor jobs, with no major jobs having been encountered in some time.

The organization in the Engineering Prototype Division also reflected the lower workload, as did the lack of a centralized engineering service group. Where the division formerly employed several production controllers to receive new work, prepare estimates, and schedule production, this work was now being done by the individual shop foremen, due both to the smaller workload and to requestors' demands for more direct access to shop working levels. Individual shop foremen were left to resolve scheduling conflicts as best they could. The result was a rather large shop facility operating at reduced capacity, which permitted quick response to customers on a wide variety of small jobs.

Funding for the division was by Navy Industrial Funding (NIF), but cost reports were minimal and were to a large extent manually processed. A method had been developed to allow the customer a choice of a fixed-price contract or a billing to cover actual costs including overhead. After an initial favorable response to the fixed-price method, most customers eventually found the actual-cost method more attractive, preferring to cover cost overruns only on their own jobs, rather than contribute to a fund that would cover overruns for others. The manager was proud of their reorganizing to meet changing demands, but was concerned that the more attractive larger jobs were being sent out to private contractors. It was not clear whether the lower workload was due to NIF or to Navy policy encouraging contracting to the private sector.

4. Raytheon Company, Oxnard Facility. Raytheon's Oxnard Facility was originally established to support flight-test operations of the company's Sparrow missile at Point Mugu. Over the years, however, the facility has taken on work from other parts of the company, so that repetitive production (mostly of electronic test equipment) had become eighty percent of the workload. The plant operated on a matrix method with Contracts, Program Development, Administration, and Controller offices as staff groups, and the Program Office, Engineering, Manufacturing, Quality Assurance, and Flight Test as line departments reporting directly to the plant manager. Out of a total of approximately 500 employees, there were 150 in the Manufacturing Department including 15 on the production control staff.

A typical job would originate as a "Request for Bid Information," coordinated by the Contracts Office. An engineer from the Program Management Office would then obtain cost and schedule estimates from each of the operating departments, prepare the complete proposal, and route it through the Controller, where appropriate mark-ups were

added, and then back to the Contracts Office. Later, when authorization to work was received, documents were forwarded by the Contracts Office to the Controller, where accounting information was added. Finally, it would go to the Program Manager, who was assigned responsibility for accomplishing the job. He then authorized the Engineering Department to begin work, and the Manufacturing Department to prepare for production. After production drawings had been completed and long-lead-time materials ordered, the Manufacturing Department ordered the balance of materials, prepared detailed scheduling plans, initiated production, and monitored progress until the job was complete. Engineering remained active throughout production, answering technical questions and making design changes as the need arose. But it was the Program Manager who retained overall responsibility for coordinating, directing, reporting, and financial control.

The Raytheon organization chart shows the three mentioned departments to be of equal stature in a line capacity. They operate in a matrix manner, with the Program Manager drawing his basic support from the Engineering and Manufacturing Departments, using the assistance of the Controller, Administration, and Contracts staff offices, and reporting directly to the plant manager. Since each department had participated in the estimates and was responsible for its own detailed scheduling within the overall plan, there was a fairly strong feeling of commitment toward meeting cost and schedule objectives.

5. Northrop Corporation, Ventura Division. Northrop Ventura is the outgrowth of an operation for the design and manufacture of pilotless radio controlled aircraft target drones. While the company still produces a number of aerial targets for the Navy, Air Force, and several foreign governments, it has expanded into design and production of underwater systems, such as the Mark 30 underwater target used by the Navy. It also performs extensive component manufacturing for the parent Northrop Corporation. With a technical advantage in the glass fiber reinforced plastics field, the company produces honeycomb wing panels for the Northrop F-5 aircraft and honeycomb fairing shapes for the Boeing 747. Other products include electronic modules for aircraft and parachutes for the Apollo space capsules.

The Ventura Division consists of several program offices supported by four major line departments: Engineering, Production Operations, Financial Management, and Marketing. Although oriented to the manufacture of considerably larger assemblies and sub-assemblies than the Raytheon Oxnard facility, Northrop Ventura Division operates in a similar manner. Work comes in through the General Manager to a Program Office. Operating in a matrix manner the program manager

authorizes, monitors, and controls the work of the Engineering and Production Operations Departments, who do their own scheduling and control within the overall plan. Each department is responsible for meeting cost and time constraints, and each has the ability to utilize overtime or sub-contracts as necessary in meeting its commitments.

Within the Production Operations Department, two methods of operation were found, dependent upon whether the production was to be high-volume standard production or one-of-a-kind pre-production or prototype work. For high volume or repetitive work, another matrix within the Department was used, with a product manager coordinating the work of Manufacturing Engineering, Material and Production Control, and Production. Estimating and scheduling were done by Material and Production Control, without consulting production supervisors. It was generally acknowledged that historical data, recalled by computer, were appropriate for establishing goals. For pre-production or minor jobs, however, requirements were sent directly to that section of Production called Advance Production, commonly referred to as the "Model Shop." There a product manager planned the entire job, including material ordering, scheduling, and production monitoring.

In either case, cost and schedule estimates submitted by line managers were occasionally modified by top management to allow for economic or market conditions, and thus enhancing their bid position. However, the line managers, having had their input felt that the goals required of them were not unreasonable.

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